VERTICAL FARMS: INNOVATIVE TEACHING STRATEGY TOWARDS NEARLY ZERO ENERGY BUILDINGS

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ABSTRACT

The paper describes the experience made and results obtained during the experimental course *Laboratory of Architecture and Structure* at the University of Florence, in which the architecture process is explored including sustainable concepts versus Nearly Zero Energy Buildings, integrating renewable energies in high-rise buildings. The innovative approach was taken due to the fact that up to now, in most Architectural schools, projects are usually seen as a synergy of different competencies often not oriented toward efficient buildings. The synergy between different teachers and their specific knowledge has been very interesting in the development of a six-month course in which 75 students were involved. They produced a complex design in which technological aspects were investigated in an integrated approach as a language of design starting from the study of the climatic context. This should be one of the most diffused approach into architectural schools but normally requires different competencies and the effort has to be made first by a strong interaction through teachers. The course of 144 hours was divided in three sub-courses that in a synergic effort developed the following themes: structure, innovative technologies, design; the results are projects of a maximum height of 100 m, in which different functions – residential, commercial, administrative - are integrated and studied in connection with the public transport in Scandicci, near Florence. The educational approach and the synergies are all oriented versus a sustainable architecture of a Vertical Farm.

Keywords: Nearly zero energy buildings, vertical farm, education and sustainability

INTRODUCTION

Faculties of architecture are usually oriented to develop an architectural project with a prevalent and often monographic view. This approach does not give an integrated and structured basis to students: after university, they usually have to make a strong effort to see a project as a whole, converging different singular experiences made during their studies. The today required competencies in Europe are very extensive: a professional has to cover many aspects of the project and specialized teams are often dedicated to the improvement of such aspects, i.e. integration of renewable energies in buildings for more efficient solutions.

In this paper, the experience of the *Laboratory of Architecture and Structure* at the University of Florence represents a significant add-value for students as well as for teachers that have to find an appropriate manner to teach and to cover three main different aspects of a project like a professional team:

- Structural development and dimension
- Design of the project concept
- Development of technological aspects oriented to low energy buildings and sustainable habitat.

METHOD

The course is held at the fourth year of Architectural studies, followed by 75 students. Students are required to develop the project in small groups (two or three students). Lessons are held three times per week, 12 hours in three disciplines with a common theme to be developed. The course takes six months and students follow each lesson to better focalize on the objective of the course. In this first annual experience, teachers had to spend a major effort: they met students several hours outside their official lessons, giving their specific contribution under common revision sections for a better final elaboration of the project. The project to be developed is located in Scandicci, near Florence, in an area with the following dimensions: 100 x 100 square meters. In this area, the Municipality intends to realize a vertical farm of a maximum high of 100 meters. The tram that connects Florence center with Scandicci's Hospital marginally serves the area. The course mainly focused on reaching a complex approach to the design project; the design is conscious of several aspects such as the complexity of the structure of a high building, the climatic effect on huge buildings in which exposition can suggest different technological solutions or different final usages of particularly exposed portions of the building. The required integration of plants, not just as an additional theme of the project but as the main part of it, generated several interpretation of the design. The vertical farm with greenhouses, sometimes for the community, sometimes for external commercial products, has several and different interpretations: sometimes plants are on vertical facades also to mitigate the microclimatic condition, in other cases they are on flat terraces or in greenhouses. Different are also the formal, technological and structural solutions that sometimes change within the same project. For logistic mobility, it is required that the project integrates a tram-stop, on the line that connects Florence to Scandicci's Hospital.

RESULTS

The most interesting results reached by the experimental course are related to the following different aspects:

- The innovative interdisciplinary approach that requires a very good communication and interaction and integration of competencies through teachers of the course;
- A very strong effort made by students in the design of a complex building, in which residential and commercial and offices are designed under the optic of a sustainable building. The term "sustainable" is related to the most appropriate relation between people and: the Greenland, public sustainable mobility, energy efficient components for energy saving, integration of renewables, indoor comfort.

Some results are presented below.

Figure 1: Example of vertical farm project. External view of the building. Credits: Zabotina N.

Fig. 2. This project is based on the concept of a modular building, with an external dynamic surface and solar shading devises. The building can grow with the necessity of funcionalities. Several functions are included such as a restaurant, a supermarket, a library, a little space for music, flats and offices and commercial destinations are studied in a concept of a vertical city. Credits: D. Pedrini, L. Pilati

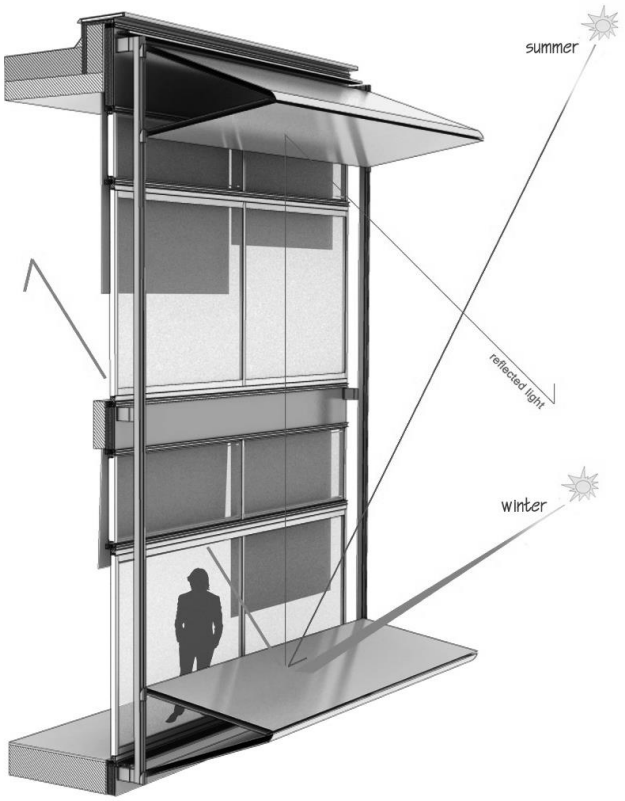
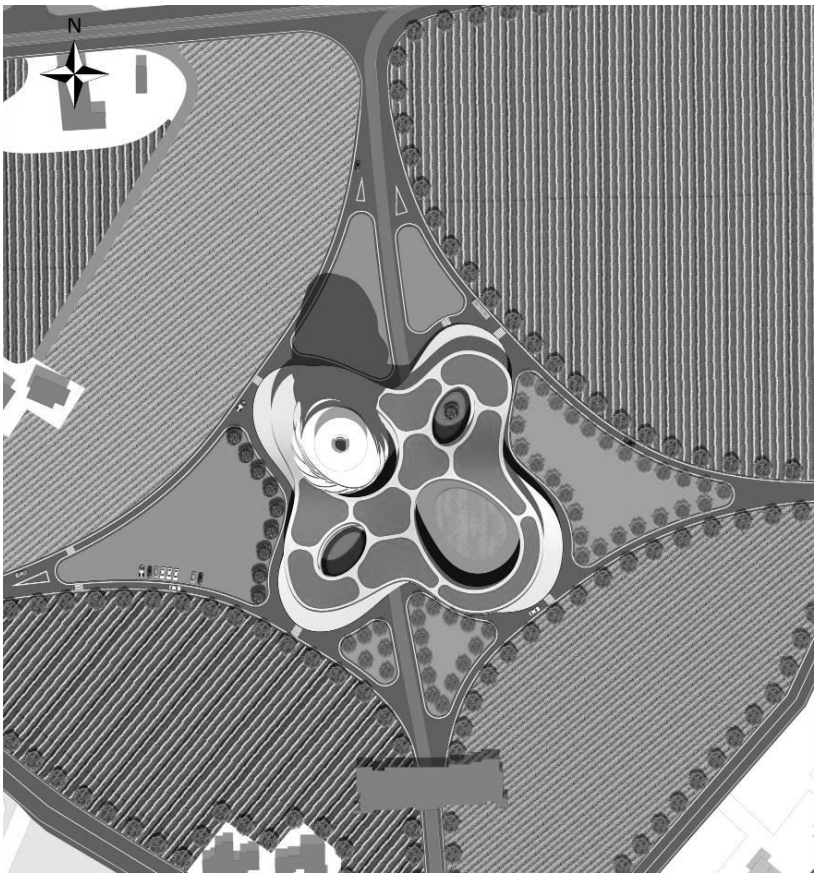


Fig. 3. All projects are simulated to better define solar shading devises or vertical green facades in the most appropriate orientation. Above, a detailed study of the solar shading device chosen in the project. Often, external shading devises are FV panels for the production of electric energy. Credits: D. Pedrini, L. Pilati



Figures 4, 5: Rendering of the Hill-Project and masterplan. The idea of the vertical farm is in this project developed with growing food on flat terrace at dedicated residential part of the building. As required, the tram has to stop nearest the new building. Credits: D. Locchi, W. B. Zhang

DISCUSSION

Each group has developed a project taking into account most of the requirement. The idea to design low energy buildings is often not fully developed due to the not adequate time given to the student for the development of the course; however renewables are normally integrated and building components adequately chosen with low U value and effective thermal mass on south, south east and south west orientation.

CONCLUSION

The theme proposed to students is very interesting but possibly too complex for a six-month course; nevertheless, the results were brilliant despite the fact that the final exams had to be postponed to allow more time to finish the projects. The experience calls for a more contained project from the dimensional point of view, giving the opportunity to all students to close the exam of the Laboratory in time.

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